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Special Scientific Report No. 47

DEVELOPMENT OF FISHERY STATISTICS IN THE NORTH ATLANTIC

by

George A. Rounsefell

Issued February 1948
Washington, D. C.

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TABLE OF CONTENTS

	Page
Necessity for accurate statistics	1
Development of the statistical system	2
Annual canvass	2
Vessel landings	3
Boat landings	3
Gear categories	4
Fishing time	4
Fishing grounds	5
Classification of fishing banks, 1891-1935	5
Development of accurate information on banks fished	6
Collection of statistics by subareas, 1936-1938	8
Revision of subareas, 1939-1942	11
Final revision of subareas, 1943 to date	14
Conversion factors	15
Interviewing	16
Summary	17

DEVELOPMENT OF FISHERY STATISTICS IN THE NORTH ATLANTIC 1/

NECESSITY FOR ACCURATE STATISTICS

The major problem of marine fishery biologists is to determine the proper level at which to maintain the fish populations in order to obtain the maximum sustained yield. Continuous observation of these fluctuations and trends in abundance is essential. Because of the inherent difficulty of estimating the abundance of a population that cannot be enumerated, most early biologists were content to concentrate their studies on other phases of the life history, basing their estimates of quantity largely on casual observation. Since the work of T. Weymiss Fulton, at the beginning of the century, most investigators have realized that trends in the abundance of marine species can be followed from year to year by means of statistics of the catch. The accuracy with which changes in the populations can be followed depends largely upon the care shown in collecting data. No one system for collecting statistics has been devised that will fit all fisheries, owing to differences in fishing methods, ways of selling the catch, the number and size of the landing ports, and the type of records kept by the fish buyers. The setting up of an efficient system for obtaining the necessary data is a biostatistical problem of major importance to conservation.

To follow changes in abundance not only must the total fish catch in numbers or pounds be recorded, but also the catch from year to year made as a result of standardized units of fishing effort. The sea can be regarded as a vast water-ranch populated with various kinds of livestock (or fish). The areas covered by the fishing fleets comprise waters of various depths, temperatures, and salinities. Each species of fish is normally most abundant on the banks most suitable to it. Different stocks of the same species may inhabit two neighboring banks, yet be separated by waters of such depth or temperature, or by such unsuitable bottom, that the two stocks mingle slightly or not at all.

Such barriers to free migration change the problem from the simple one of sampling a single population to the vastly more complex one of sampling a series of populations, each of which may be at a different level of abundance. If one thinks of the abundance of a species as its relative density it is obvious that an increase from 500 to 1,000 fish on a square mile of poor bottom is as large a relative change as

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1/ No record of the development of these statistics is complete without mention of Frederick F. Dimick, now retired, who commenced the collection of statistics at Boston in 1891 and continued at his post for more than 40 years--or the late Walter H. Rich of Portland, Maine, author of "Fishing Grounds of the Gulf of Maine." William C. Herrington, who has made many helpful suggestions, pioneered the early stages in the development of the technique of obtaining accurate information on fishing locations and fishing time, and also in the adoption of subareas for the reporting of the statistics.

one from 5,000 to 10,000 fish on more suitable bottom. Unless the statistical system used makes a separation of these two areas, the true change in relative density may be lost or obscured. This is illustrated by the following data:

Area	Catch		Days fished		Catch per day		Percentage change
	1st year	2nd year	1st year	2nd year	1st year	2nd year	
A	500	5,000	10	50	50	100	+100
B	25,000	10,000	50	10	500	1,000	+100
A & B	25,500	15,000	60	60	425	250	-41

An efficient system for collecting fishery statistics will show the true relative change in density (or abundance) of the populations whereas a system that combines areas with different characteristics may give a false impression.

DEVELOPMENT OF THE STATISTICAL SYSTEM

This paper on the development of the system of collecting and publishing fishery statistics for the North Atlantic has been presented to show the necessity for close integration in the collection of statistics for the trade with those used for biostatistical analysis, to show the type and accuracy of the information needed, and to guide those using fishery statistics of the North Atlantic published in past years. This section deals with the evolution of the present system and also points out the limitations in the data for various years.

Annual Canvass

When the study of the changes in abundance of haddock was commenced in 1930, a survey of the available statistics was made. It was found that the statistics being collected were of two kinds. The first showed the total production of the fisheries and was tabulated by the counties and States in which the fishing vessels making the catches were registered. These landings were collected by canvassing the fishermen directly and obtaining their total catch for the year. These annual canvasses had been made only in certain years: 1887, 1888, 1889, 1898, 1902, 1905, 1908, 1919, 1924, 1928, 1929, and 1930. As they gave no indication of the localities wherein the fish were caught, or the seasons during which they were taken, or the amount of fishing effort expended in making the catch, they served only as an indication of the total annual drain upon the banks as a whole

Vessel Landings

The second type of statistics collected was the landings of fish by vessels (of 5 net tons or more, official register) at certain ports. Although these statistics do not give the total production, they include the great bulk of the catch from the offshore banks. These records, first published in 1891 and annually since 1893, at first included only the landings at Boston and Gloucester, Mass., by years, and showed the quantity of each species caught on each bank as well as the total number of trips (absences from port) made by vessels of all types. Beginning in 1898, these statistics also showed the landings by months (but these first monthly totals were not listed by individual banks.) Since 1902, landings by banks have been published each month in pamphlet form. Since 1916, the landings at Portland, Maine, were included with those from Boston and Gloucester, Mass., and the series of monthly bulletins was entitled, "Landings by fishing vessels at the three principal New England ports." A summarized version of these landings was also published annually in the report of the United States Commissioner of Fisheries.

Owing to increased landings of fish at other New England ports in recent years (especially at New Bedford which surpassed Portland, Maine, in 1939) the title of this bulletin was changed in March 1940 by the Bureau of Fisheries and continued by the Fish and Wildlife Service (July 1940) to read, "Landings at certain New England ports." As an aid to the statistical agents in making their annual canvass of the region, more or less complete landings by individual vessels have been obtained from Provincetown and New Bedford, Mass., since 1938, and from Woods Hole, Mass., since 1942. Beginning with January 1944, the landings from these additional ports are being published monthly in a form similar to that for Boston, Gloucester, and Portland.

Boat Landings

In addition to the documented vessels of 5 net tons or over, there are a considerable number of smaller craft referred to as "undertonnage" boats, fishing out of these ports. The catches of these undertonnage boats, although included in the annual canvass, have not been published currently, despite the fact that they land a considerable portion of the total at some of the minor ports. These boats fish chiefly with line trawls, otter trawls, drift gill nets, and harpoons. Commencing with January 1944, the catches of these boats are published monthly for the ports of Boston, Gloucester, Portland, New Bedford, Woods Hole, and Provincetown. As the operators of these boats are not usually interviewed, the number of days absent and the grounds fished are not shown. However, as these boats fish in the area close to the port of landing, and the trips usually are not longer than one, or sometimes two days, the number of trips and catch by months for each type of gear used supply ample information.

For Boston the statistics for landings of fish by the smaller inshore vessels are not so complete for the period from 1914 to 1943, inclusive, as are those for the earlier years, owing to the building of the Boston Fish Pier which was completed on March 28, 1914. At that time the larger vessels began landing at the new pier, but many of the smaller inshore vessels continued to land fish at the old T wharf on Atlantic Avenue. These T-wharf landings are not included in the monthly landings from the three ports during this period but were again added beginning in January 1944.

Gear Categories

A great forward step in the collection of the monthly statistics occurred in 1929 when the landings were tabulated according to types of gear used in making the catch, as well as by fishing banks. It was now possible to follow seasonal changes in the fishing intensity by each of the various forms of gear. Prior to this improvement in tabulation, the changes in the number of trips represented chiefly variations in the trips by the numerically superior small-vessel fleet, whereas, the larger vessels were landing the bulk of the catch. The smaller craft made many more trips than the larger as they usually went out for only one, two, or three days, while the large otter-trawl and line-trawl vessels were usually absent from port for periods ranging from one to three weeks. Another improvement made in 1929 was the classification of the otter-trawl fleet, which has landed the bulk of the catch in recent years, into size categories. They were grouped as: small, 5 net to 20 net tons; medium, 21 net to 90 net tons; and large, 91 net tons or over. This grouping permitted a better estimation of fishing intensity as the larger vessels caught much more per day's fishing. Since January 1937, this classification of otter trawlers has been based on gross tonnage, as follows: small, 5 net to 50 gross tons; medium, 51 gross to 150 gross tons; large, 151 gross tons or over. This new classification closely approximates the older, except for that of a few boats. It was found that the gross tonnage more nearly coincided with the fishing capacity of the vessels than the net tonnage so that the new classification represents an improvement.

Fishing Time

When the tabulation of the landings by types of gear was inaugurated in 1929, the number of days absent from port was also added. This was a great improvement over showing only the number of trips, as the length of trip varied considerably between vessels of different sizes and between voyages to banks at various distances from the landing port. In computing the number of days absent from port, the day of sailing was counted as a day at sea as was also the day of landing. For a small vessel making a one-day trip the error was slight, but for most trips the time at sea was overestimated by one to one and one-half days. As the larger otter-trawl and line-trawl vessels usually leave port

during the early afternoon and land in the early morning, this method overestimated the number of days absent by about one and one-half days per trip. Commencing with January 1944, this discrepancy between the actual and calculated number of days at sea was greatly reduced by counting the day of arrival at port as a day absent and omitting the day of sailing. Thus, a boat sailing on the 6th day of the month and landing on the 12th would be absent 6 days. This might still appear to be slightly in error for the smaller vessels which often make short trips. Thus, a boat leaving and returning to port on the 6th would be counted as absent one day (including the da y of landing). A boat sailing on the 6th and landing on the 7th would also be counted as absent one day. Theoretically, it could be absent for a period up to 48 hours, but would be more apt to be absent for one day. The sink gill-net vessels, which make most of the short trips, usually leave port in time to reach the nearby banks before dusk and return to port the next morning with the catch so that an absence of one day approximates the actual time at sea much closer than the former allowance of two days.

Fishing Grounds

Classification of fishing banks, 1891-1935. The fishing grounds used in these monthly statistics were not at all comparable in size, ranging from Georges Bank (producing 147,000,000 pounds of fish in 1930) with an area of over 9,000 square miles to such small banks as Fippennies, (yielding a 1930 catch of 86,000 pounds) with an area of about 35 square miles. In addition, the boundaries of the banks were not clearly defined but varied with the ideas of the fishermen.

Figure 1 shows the names of the fishing grounds by which the statistics for 3 ports were compiled until 1936. This classification was obviously far from ideal for biological investigations as it gave unnecessary detail for catches from many insignificant banks while lumping the landings for many large areas. The catches were not so well located as the chart designations would indicate. An attempt has been made in figure 1 to show the location of all the New England and Nova Scotia fishing grounds for which any landings are given in the published statistics; but some of the fishing grounds indicated have only appeared in the records once or twice in fifty years.

The banks off Nova Scotia were poorly defined. Thus, the term Sable Island Bank (or sometimes Western Bank) was often used to include all the grounds from Emerald to Misaine Bank. Banquereau, however, was usually tabulated separately. The Gully appears in most years, but Misaine and Canso Bank are rarely shown. La Have Bank and Browns Bank nearly always appear but there is considerable fishing in the undesignated area lying between them, shown on early charts as "Baccaro" Bank and known to most fishermen as "Little La Have." There is no means of knowing to which bank these catches were credited as in posting the catches for auction the fishermen might hail them as from either Browns or La Have. The term "Cape Shore" was extremely inclusive, taking in all inshore catches from Seal Island Grounds

(and sometimes including them) as far east as Canso Bank and beyond. In the earlier years it apparently often included catches as far as Scatari Bank and even to Cape North. It is believed that many offshore catches, especially of line-trawl vessels, were credited to Cape Shore.

The banks off New England were somewhat better defined. Many small banks usually appeared in the statistics, especially Jeffreys Ledge, Middle (Stellwagen) Bank, Platts Bank, Fippennies Bank and Cashes Ledge. Jeffreys Bank and Bank Comfort appear very rarely. Bank Comfort is not a bank but merely a small part of the bottom in deep water that is suitable for fish. Tillies Bank, shown as a depth contour on early charts does not appear on later editions, but often appears in the early statistics. The term, South Channel, was rather loosely applied and its boundary with Georges Bank cannot be accurately defined. Most of the small-boat catches in the western portion of the South Channel were designated as "Off Chatham" or "Off Highland Light." The catches from one very small portion of Georges Bank were often tabulated from "Clarks" or "Clarks Bank." Early charts showed a bight here in the 50-fathom contour line which later soundings have shown to be erroneous, but it furnished the fishermen with a convenient designation. The term "Shore, General" appears in nearly every year and includes the catches of a great part of the small-vessel fleet for which the fishing locations were not obtainable. It includes the inshore waters from southern Massachusetts to eastern Maine. Doubtless a great part of these catches were from Middle Bank, Jeffreys Ledge and the coastal waters of Maine.

Development of accurate information on banks fished. In order to collect more accurate data for biological investigations, the banks were divided into areas of more suitable size in 1931. For this first attempt at subdivision, the banks off Nova Scotia and in the northern Gulf of Maine were divided into what appeared to be natural fishing areas from information furnished by captains of fishing vessels. For the banks south and east of Cape Cod, including Georges Bank, the division was based on the localities fished by the otter-trawl vessels of two large companies. The number of days fished in each locality was plotted for each vessel from its log book. This information, available for 1928, 1929 and 1930, totaled 8,329 fishing days.

The resulting subdivisions, shown in figure 2, were used in the analysis of haddock data collected during the fall of 1931 and in 1932. In obtaining vessel landings by these subareas for the biological work, it was decided to use some system for obtaining fishing positions with sufficient accuracy to permit the relocation of subarea boundaries as more evidence accumulated. At first the fishing positions were located by obtaining the vessel's magnetic bearing and its distance from some landmark, such as a lighthouse, buoy, or point of land. A man was stationed on the Boston Fish Pier to interview the captain or

first mate of each large or medium-sized fishing vessel as it landed its catch. The depth fished and the proportion of the catch taken there were recorded for each position. To obtain a measure of the fishing effort, each otter-trawl captain was asked the hour and date of departure and of arrival at the pier, the number of hours or days spent in fishing on each bank and the number of hours or days wasted (not including regular running time to and from the banks) by jogging at slow speed in bad weather, the tearing of nets,or other unusual circumstances. For line-trawl vessels the number of tubs of trawl line set at each position was noted as well as the proportion of the catch taken there.

The method of obtaining fishing positions by compass bearing and distance was abandoned after a few months' trial as an error of a quarter point in a bearing makes a large error in a position when the distance from land is considerable, such as eastern Georges Bank. A captain or a mate often may not remember the distance or bearing from any particular point, but can quickly point out on a chart the places fished. It was, therefore, decided to obtain the position by showing the fishing captain a chart of the area. These small charts were encased in transparent celluloid as a means of protecting them from rain, dirt and slime.

It was now necessary to have some means of designating convenient-sized small areas so that the fishing positions pointed out by the captains could be jotted down on a note pad. From the previously gained experience it was decided that in general it was not practical to obtain positions with any greater degree of accuracy than 10 minutes of latitude or longitude; therefore, the area enclosed by 10 minutes of latitude and 10 minutes of longitude was chosen as the smallest unit and called the "unit" area.

The unit area is 10 nautical miles north and south. In an east and west direction it varies with the latitude from about 7 to nearly $7\frac{1}{2}$ miles between Quereau Bank and southern Georges Bank, thus containing between 70 and 75 square miles of bank area. The block of 36 unit areas lying between each degree of latitude and each degree of longitude is given the designation of the degree of latitude lying to the south and of the degree of longitude lying to the east. Thus, the block lying between 41 and 42 degrees of north latitude and 66 and 67 degrees of west longitude is designated as 41-66.

To differentiate between each of the 36 unit areas within the degree block, it was first decided to number the unit areas consecutively from 1 to 36 in the same manner as the 36 sections of land in each township are numbered in the surveys of public lands. This method proved too cumbersome as it was difficult to remember the number of a unit area merely from its position within the degree block. In the system finally adopted each column of unit areas from west to east was designated by a letter, the letters running from A to F. Each row of unit areas from

north to south was given a number, the numbers running from 1 to 6. In this manner a unit area anywhere in the North Atlantic can be jotted down without difficulty. Thus, the unit area bounded by 41 degrees 30 minutes and 41 degrees 40 minutes north latitude and by 66 degrees 30 minutes and 66 degrees 40 minutes west longitude is known as 41-66 C3.

In organizing these unit areas into the larger subareas the boundaries of the subareas were laid out on a rectangular basis to conform to the boundaries of the individual unit areas. Exceptions were made where the subarea made contact with the shore, the final boundary line being placed on county or State lines to facilitate the tabulation of the inshore catches.

The areas as first outlined were used in analyzing the biological data on haddock and in tabulating landings during 1931 and 1932. The boundaries of several of the areas were found to be poorly placed and in 1933 new boundary lines were drawn, as shown in figure 3. For this first revision, 4,470 fishing days by otter-trawl vessels were added for the Georges Bank and South Channel regions, making a total of 12,799 days' fishing. Many of the changes were minor in character, involving the slight shifting of a boundary line to avoid splitting off a portion of a fishing concentration.

Collection of statistics by subareas, 1936-1938. In the South Channel areas G1, G2, and G3 had not been well placed and the Channel was now divided north and south into the west side of the Channel, G1, and the east side, G2. On Georges Bank the area G7, East of the Shoals, was largely combined with the Shoals, G6, into a new area, G3. Other minor changes on Georges Bank contributed toward a better division into natural areas. The Boston otter-trawl vessels were not fishing to any great extent, at this period, on the Nova Scotia banks so the data were insufficient for accurate division into natural areas, the only change being the merging of W2 and W4, Sable Island and Middle Ground, into one area, W4. These revised areas were used during 1933, 1934 and 1935, in the biological analysis of statistics.

Fishery investigators from the United States and Canada, meeting with fishery advisors at the North American Council on Fishery Investigations, in 1936, decided to make the boundaries of the subareas coincide with the boundaries of the International Statistical Areas. These International Statistical Areas were first used in Europe by the International Council for the Study of the Sea to facilitate the uniform reporting by different countries of the origin of the catch of various species of fish. These areas had been extended by the North American Council on Fishery Investigations in 1931, to include the Atlantic coast of North America from Greenland to Cape Hatteras. The numbers were an extension of those used in Europe: Area XIV on the east coast of Greenland; XV for the west coast of Greenland; XVI for Hudson Bay; XVII for the Labrador Coast; XVIII for the northeast coast of Newfoundland; XIX for the Gulf of Saint Lawrence; XX for the southeast coast of Newfoundland, which in-

cluded most of the Grand Banks; XXI for the banks off Nova Scotia; XXII for the banks off New England, including the Connecticut Shore of Long Island Sound; and XXIII for the Middle Atlantic States.

The boundaries of the International Areas set up in 1931 were modified slightly at the meeting in 1936 in order to make them follow as closely as possible the boundaries of the unit areas used in determining fishing positions, and the boundaries of the main subareas as previously determined. It was also decided to discontinue the former designations, such as H1, H2, etc., for the various subareas and follow the International System of starting with A in each main area. There were available at this time 8,838 additional plots of day's fishing positions of otter trawlers in Area XXII, making a total of 21,637 for this Area. The inshore grounds needed the most revision as the chief attention in previous delimitations of subareas had been given to Georges Bank. Now, it was necessary to subdivide the whole of Area XXII carefully in conformity with the practices for the International Areas. The resulting subareas are shown in figure 4.

The chief accomplishment of the 1936 meeting was the subdivision of Area XXI according to natural subareas. Previous divisions had been based on general information supported by little actual data, but now there were available 2,891 charted positions of day's fishing positions by American otter trawlers. In addition, the Canadian investigators were well acquainted with the banks fished by their vessels. The areas that include Browns Bank, La Have Bank, and Banquereau were left essentially as before but the offshore banks from Emerald to Sable Island, previously divided roughly into two subareas were broken into six subareas: Emerald; Horseshoe Ground; Middle Ground; Northeast, Southeast and Southwest, Sable Island Banks. These are shown in figure 4.

Now that the banks had been subdivided on the basis of several years of analyzed data into logical subareas it was deemed advisable to have the monthly statistics of vessel landings at the three principal New England ports, collected and published according to the subareas instead of by banks. The disadvantages of reporting the statistics by bank, regardless of size, have been discussed already. The Division of Fishery Industries, now the Division of Commercial Fisheries, Fish and Wildlife Service, which is responsible for the collection of these statistics, had long been following the development of this system and immediately took steps to report landings by these new subareas, commencing with January 1936.

The practice of reporting by subareas rather than by fishing grounds, the monthly statistics of the catch landed at the three principal ports was a vast improvement. For example, previous to 1936 a landing was allocated to the particular fishing ground specified by the captain, regardless of the fact that a large portion of the catch might have been taken on additional grounds. Under the new system the biologist's interview was used to determine accurately the location of the fishing grounds from which came all Boston landings by vessels over 50 gross tons.

The statistical agents of the Service were to interview the captains of as many as possible of the smaller vessels landing at Boston and all sizes of vessels landing at Gloucester and at Portland, Maine, to determine their approximate fishing locations by the subareas of the new system. During 1942, a biologist was stationed at Gloucester, Mass., in connection with studies on the rosefish, and since May 1942 the data for fishing areas and number of days absent for vessels landing at Gloucester have been obtained in the same manner as were the statistics for Boston. The statistics for New Bedford, first published in January 1944, are also based on personal interviews, obtained by biologists studying the important fishery for yellowtail flounders centered at that port.

The more accurate information permits the division of the catch of any particular vessel between two or more subareas in which it has fished, so that since 1936, the amounts caught in each subarea took on an accuracy impossible to attain under the former system. The accuracy of location by smaller fishing grounds, such as Middle Bank, Cashes Ledge, etc., under the old system, was more apparent than real, and the consolidation of many of these tiny areas was far more than compensated for by the elimination of such large, loosely-designated areas as Cape Shore, Western Bank, Georges Bank, and Shore, general.

Because of complications in the tabulation, when this new system was inaugurated in 1936, a vessel was credited with one trip for each bank fished so that if a vessel fished in three subareas during one absence from port it was credited with three trips. This prevented the appearance in the statistics of a subarea showing a catch for the month but no trips in cases where no vessel fished there for more than a fraction of a trip. However, this greatly overestimated the true number of trips so, commencing with January 1939, only one trip is shown for each absence from port. When a vessel fishes in two or more subareas during the same voyage the trip is prorated to the nearest tenth of a trip between the areas on the basis of the volume of the catch reported as caught in each subarea.

The number of days absent from port was prorated to the nearest day between the subareas fished on each trip on the basis of the volume of the catch reported as is now done with the trips. However, the prorating of the days absent from port was commenced in 1936 when the new system was adopted so that it is not in error during the 1936-38 period, as is the number of trips.

A further revision of the subareas adopted in 1936 was soon made necessary by several developments, chief of which were as follows: the extension of the biological studies to additional species; the development of fisheries for rosefish and gray sole which caused the vessels to fish in portions of the deep waters formerly unproductive; and the necessity for simplification to permit the handling of the enormous masses of data which had to be treated in analyzing trends of abundance for various species.

Revision of subareas, 1939-1942. Early in 1938 the Service began a study of the abundance of other species of New England groundfish in addition to the haddock, namely, the cod, pollock, whiting, cusk, wolffish, hake, halibut, rosefish, and various flounders; their inclusion caused certain changes in the biostatistical analysis. In a fishery seeking several species the abundance of any one is not necessarily portrayed by a simple calculation of the average catch of that species made as the result of a certain amount of fishing effort. Any statement concerning the average catch of a species needs to be qualified by information as to the depths, as well as the grounds fished, and the quantities of other fish taken. It must be made clear whether the average cited is derived from fishing effort directed toward the catching of that species, or is merely the average of catches made incidental to the pursuit of another species.

The need for information on the depths fished in order to determine the amount of fishing effort assignable to different species is well illustrated by the rosefish and gray sole fisheries. When the 1936 revision of subareas went into effect these fisheries were in their infancy, the 1935 catch of rosefish landed at the three New England ports amounted to only 17,000,000 pounds. In 1936, the rosefish landings increased to 67,000,000 pounds and have remained at a high level. Vessels fishing primarily for rosefish trawl exclusively in the deeper waters; only an occasional rosefish is taken in the shallower areas, and even the medium depths (31 to 60 fathoms) do not yield them in commercial quantities. In a few areas, gray sole are sufficiently abundant to supply a profitable reason for fishing certain grounds. They are also taken chiefly in deep water, often with the rosefish. Some of the flounders, especially the yellowtail and the blackback, are found in abundance on certain shoal grounds, but only in slight numbers in medium depths, and are scarce or absent in the deeper waters.

Since the abundance of a species can thus be accurately measured only by the size of the catches made while fishing in depths and on grounds where the said species is normally present, it has been necessary to analyze the data by depth zones. The zones used in the analysis of abundance are: shallow, 0 to 30 fathoms; medium, 31 to 60 fathoms; and deep, over 60 fathoms.

In relocating the subarea boundaries, many slight adjustments were made to fit them more closely to the depth zones. Thus, if the subarea contains almost all shallow or medium depths the inclusion of one or two unit areas of deep water necessitates the tabulation of an additional category of catches for that subarea even though the deep area may be so small or so little fished that the category in question does not provide sufficient data to yield any reliable averages. By making several slight adjustments for depths in subarea boundaries, the tabulation of the data was greatly facilitated.

The boundaries of the subareas as outlined in 1936 were based largely on the charted positions of day's fishing by otter trawlers. At that time, data were available for 21,637 days' fishing in Area XXII and 2,891 days' fishing in Area XXI. The revision of boundaries to fit the needs of the new study of groundfish abundance, which went into effect in January 1939, was based on 32,376 days' fishing by otter trawlers in Area XXII and 7,256 in Area XXI. In addition the number of tubs of gear fished by line-trawl vessels in each unit area during the first eight months of 1938 was utilized. The Canadian investigators advised on several minor shifts in the subarea boundaries of Area XXI.

The subareas adopted in January 1939 are shown in figure 5. Where two subareas have been merged, an attempt was made, insofar as possible, to place the new boundary lines so as to have the new correspond roughly to the two old subareas. Thus the monthly statistics of the landings at the three principal New England ports which were collected from 1936 to 1938 by the 1936 subareas, can be easily compared to those collected by the 1939 revision, preventing any lack of continuity in the production statistics by banks.

In order to show clearly the basis on which these boundaries were drawn, figure 6 is presented showing the number of days otter trawlers fished in each unit area for the Georges Bank, South Channel and Nantucket Shoals portion of Area XXII.

From 1928 to 1937 inclusive, 40.7 percent of the days' fishing for which fishing positions are plotted in figure 6 (Area XXII South) was in the old subareas J and K. It is obvious that the fishing in these two subareas is part of a single fishing concentration following the edge of the bank, with the dividing boundary line through the center. A line through the center of such a heavy fishing concentration causes a tremendous amount of extra statistical work in dividing the catches and fishing effort without accomplishing any particular object. Therefore, the two subareas, J and K, were merged as J, except for a minor portion of the western end of J that appears to belong to the fishing concentrations of subarea H, and a portion of K along the southeastern boundary that approaches close to the fishing concentration of subarea M. The new J contained 89.3 percent as many days' fishing as the two original subareas.

Subareas L and M contributed 20.4 percent of the days' fishing in Area XXII South. The boundary between them passed through a widespread fishing concentration on a gradually shelving bottom of very even depth, resulting in a wholly artificial division; this was corrected by merging them with minor changes, as subarea M. The resulting subarea contained 107.5 percent as many days' fishing as the original two.

Subarea XXII H was revised slightly; the eastern boundary was shifted eastward toward the crest of the shoals in the former subarea XXII L and the western boundary was shifted one unit area to the east. This latter shift was occasioned by the intense fishery for rosefish that developed in the Channel after the 1936 subareas had been adopted. The center of concentration of this fishery was along the former boundary between G and H so that a slight shift in the boundary avoided the useless labor of splitting the catches of a great many Channel trips.

In the western portion of Area XXII South (figure 6) the original Nantucket Shoals subarea P was merged with subarea O. There is clearly a fishing concentration extending from beyond Nantucket Shoals lightship to the western end of Nantucket Island, and any boundary line cutting across this ground is wholly artificial.

Changes in the subareas in the northern portion of Area XXII were chiefly minor in character as there were few data available for these grounds. Subarea D was extended to include Jeffreys Ledge which is an extension of the inshore banks and belongs with the shore fisheries. For similar reasons the boundary of subarea XXII C was shifted northward so that the tiny Jeffreys Bank, far offshore, would be included in subarea F instead of with the shore fisheries of C.

For Area XXI there were available 7,256 charted positions of days' fishing by otter trawlers for use in the 1939 revision of subareas, contrasted to 2,891 for the 1936 revision. This increase in the amount of available data, coupled with the great development of the rosefish and gray sole fisheries since 1936 made possible a more logical division although the 1936 subareas were generally suitable, except in the southern portion of XXI.

The southern boundary of XXI O was originally drawn through the center of the deep water lying between Browns Bank and the banks off Cape Sable. After the development of the fishery for rosefish this line bisected a heavy concentration of fishing in unit 43-65 E6 and 42-65 E1. The boundary has therefore been shifted one unit area southward to take in all the deep water north of Browns Bank. This has an added advantage in that previously a deep-water landing from Browns Bank (XXI P) might be presumed to come from either side of the bank, whereas the rosefish were actually caught in the deep hole on the north side.

The days' fishing positions showed clearly that there are two fishing concentrations on Browns Bank. The first, at the western end of Browns Bank, occupies the Shoals and the edge of the bank just to the southward of the Shoals. This western Browns Bank region is fished extensively in spring and summer; the summer fishing is in the shallower water. The second fishing concentration centers just southeast of the "toe" of Browns Bank, extending eastward toward La Have Bank over the broad shelf of medium and deep waters just south of Little La Have Bank.

The fishing off this eastern part of Browns Bank is almost entirely in the spring. These two fishing concentrations were separated by shifting the western boundary of XXI N six unit areas (about 45 miles) to the west. There is a possible criticism for merging this eastern Browns fishing concentration with that of La Have Bank but the data do not show any point of separation as La Have Bank tends to rough bottom and is seldom fished by otter trawlers.

The subareas for Area XXI east of La Have Bank were permitted to remain essentially as before except for a number of minor changes to conform more closely with depths or fishing concentrations. The charted positions of days' fishing are not nearly so extensive as for Georges Bank, and the charted depths are relatively inaccurate. For these reasons it is probable that more extensive data may eventually indicate the necessity for additional changes. These changes may take the form of the merging of some subareas. Subarea XXI C, Banquereau, however, is of tremendous size, and may need to be divided at a later date. So far there is insufficient biological and statistical evidence to indicate that such a division is necessary, or exactly where the line shall be placed.

Final revision of subareas, 1943 to date. In April 1942, the collection of information was begun in Gloucester to obtain data for an abundance study of rosefish from vessels landing there. Information, heretofore unavailable, now was provided as to the exact fishing positions of the large fleet of small and medium otter trawlers fishing chiefly in the northern portion of Area XXII. The 1939 subarea boundaries, drawn without adequate data from this region, were obviously unsuitable for a biostatistical study of the rosefish. Accordingly, since January 1943, the catches in this region have been reported by the subareas shown in figure 7.

No information on the grounds fished by the large fleet of New Bedford otter trawlers was available until 1943 when biologists commenced interviewing the captains to obtain data for a study of the fishery for yellowtail and blackback flounders. The information indicated the need for a slight change in the eastern boundary of subarea XXII Q to separate the fishing off No Man's Land from that of Nantucket Shoals. The boundary between subareas XXII S and XXII Q also needed minor adjustment to separate the fishing southeast of Block Island from the fishing on Cox Ledge extending to No Man's Land. These minor adjustments (in effect in January 1944) are delineated in figure 7.

It will be noted that subarea A in Area XXII, the northern Bay of Fundy, has been placed in Area XXI as subarea S. Placing the catches of the two sides of the Bay of Fundy in the same area is more logical than the former division.

CONVERSION FACTORS

The annual-canvass figures as published were not always given on the same weight basis. From 1887 to 1924, inclusive, as-landed weights are given. Certain species are usually landed in the round, i.e., in the same condition as caught. This includes rosefish, mackerel, flounders, and herring. For these species the as-landed weight is the same as the total weight, usually called the round-weight. For most of the other species, including cod, haddock, cusk, pollock, hake, halibut, wolffish, whiting, and swordfish the round weight usually differs from the as-landed weight since the fish are customarily gutted before landing; in the case of swordfish and hake, the head usually is removed also. The offshore vessels follow this procedure so that the entire catch as it is brought aboard can be placed in crushed ice in the hold for the duration of the trip. In a few of the smaller ports, especially in Maine, where the catch is taken principally by small vessels making short one-day trips to nearby fishing grounds, all, or a large portion of the catch may be landed round.

Since 1928, the published annual-canvass statistics give all species of fish on the basis of round weight. In order to do this the weights of all fish landed in a gutted condition have been multiplied by a factor, differing with the species, to allow for the loss entailed in the process. This loss is estimated to vary from about 10 to 40 percent, according to the species and whether or not the head is removed. For fish that have been salted aboard the vessel before landing, the as-landed weight amounts to about 40 to 50 percent of the round weight. This change in the statistics must be taken into account in any comparison of the amounts landed since 1928 with the earlier landings.

The weights of fish shown in the monthly port statistics have always been given as landed. Exceptions were made when fish were salted aboard the vessel before landing. The weight of the salted fish was usually increased to coincide with the as-landed (not necessarily the round) weight of the same species in the tabulation by gear and fishing grounds. For haddock, cod, whiting, etc., a certain minor proportion of the catch landed round, instead of in the usual gutted condition, was converted into gutted weight before tabulation. Because the price of round fish is always lower than the price of the gutted, by an amount greater than is compensated for by converting the round weight to gutted weight , this practice caused the value of the gutted fish, as given in the statistics, to appear lower than was actually the case. Beginning in January 1944, this was corrected by giving the amounts and values of fish landed gutted and round, separately.

From the foregoing, it is clear that the value of the port statistics depends almost wholly on the care with which the information on the catch by fishing grounds is obtained from the responsible officer on each vessel. Additional data necessary for calculating the catch per unit of fishing effort is also obtained from these interviews. This basic information is being utilized in all reports on the abundance of groundfish in the North Atlantic.

The biologist making the daily interviews carries miniature charts (fig. 8) encased in transparent celluloid and a pad of interview sheets. At Boston he obtains from the blackboard in the Fish Exchange a list of all vessels landing at the pier that day, and can locate any unusual catches from the estimates of the catches of the principal varieties hailed for auction by each vessel. At other ports hails are obtained from auction rooms or dealers. He then questions the first mate or captain of each vessel about his trip, recording the information on an interview form. The vessel may have fished in only one subarea and followed closely a limited range in depth, but often has fished in several subareas. In these latter cases the interviewer must obtain the time spent fishing in each subarea, and the proportion of each of the principal species caught there.

So many commercial species of groundfish are landed that it is impractical to question the mate on all of them. However, particular care is taken to note the sources of such deep-water species as rosefish or gray sole or the shallow-water species such as blackbacks, or yellowtail, even though present in minor quantities. The porportion of cod and haddock of different market sizes taken from each area is noted, and the source of any unusual quantities of any of the minor species listed.

Figure 9 shows a typical interview of a large otter-trawl vessel. After "caught" is written the general locality fished; the next line gives the depths in fathoms, followed by the exact fishing positions in unit areas from the interview chart (fig. 8). In the center of the form is given the total estimated, or "hailed" catch, in each locality in thousands of pounds, i.e. 70M, 20M, and 40M. This is followed in succession by estimates for large haddock, scrod haddock, rosefish, gray sole, and lemon sole. Notes on large cod and on pollock are also written in.

In the next section of the form is an estimate of the time actually spent in fishing in each locality. This is followed by an estimate of lost time, which is usually caused by a net tearing up, jogging at slow speed in bad weather, or engine trouble. By subtracting both lost time and the time spent in running to and from the fishing banks, from the total time absent from port, it is possible to calculate the time actually spent in fishing, for use in studying changes in abundance.

SUMMARY

This account of the development of the system for collecting and publishing detailed statistics of the North Atlantic fisheries on a current basis has been written with a three fold purpose; first, to show the need for close integration in the collection of statistics used for the trade with those used for biostatistical analysis; second, to show the type of information necessary and the need for accuracy and consistancy in obtaining it; and third, to serve as a guide to those using fishery statistics published in past years.

As a convenience to those who use these statistics, table 1 is presented, which shows chronologically, in condensed form, the pertinent information needed in order to interpret each year's figures.

The many changes and developments that have taken place illustrate two salient points concerning a statistical system. First, a system cannot start at full maturity but must be changed as information accumulates. Second, a statistical system will not run itself. As changes occur in fishing methods, grounds, species taken, or other factors, these must be noted and the system adopted to meet them. Perhaps the most potent factor in maintaining a statistical system at peak efficiency is use. When statistics are of value and are constantly in use, they are most apt to be collected carefully.

Table 1.— Showing chronologically the development of current statistics of the catch for New England ports. 1/

Year	Ports included 2/							Source data on fishing localities 3/			Days absent from port	Type of gear	Frequency of tabulation		Fishing localities used
	Boston	Boston Fish Pier	Gloucester	Portland	New Bedford	Provincetown	Woods Hole	Hails	Biologist interviews	Statistical agents			Annual	Monthly	
1891	x	-	x	-	-	-	-	x	-	-	-	-	x	-	Banks.
1893-1897	x	-	x	-	-	-	-	x	-	-	-	-	x	-	Do.
1898-1901	x	-	x	-	-	-	-	x	-	-	-	-	x	-	Do.
1898-1901	x	-	x	-	-	-	-	x	-	-	-	-	-	x	None
1902-1913	x	-	x	-	-	-	-	x	-	-	-	-	x	x	Banks
1914-1915	-	x	x	-	-	-	-	x	-	-	-	-	x	x	Do.
1916-1928	-	x	x	x	-	-	-	x	-	-	-	-	x	x	Do.
1929-1935	-	x	x	x	-	-	-	x	-	-	x	x	x	x	Do.
1936-1938	-	x	-	x	-	-	-	-	x	-	x	x	x	x	Subareas.
1936-1938	-	-	x	x	-	-	-	-	-	x	x	x	x	x	Do.
1939-1942	-	x	-	-	-	-	-	-	x	-	x	x	x	x	Subareas (1939 revision).
1939-1942	-	-	x	x	-	-	-	-	-	x	x	x	x	x	Do.
1943	-	x	x	-	-	-	-	-	x	-	x	x	x	x	Subareas (1943 revision).
1943	-	-	-	x	-	-	-	-	-	x	x	x	x	x	Do.
1944	x	-	x	-	x	-	-	-	x	-	x	x	x	x	Do.
1944	-	-	-	x	-	x	x	-	-	x	x	x	x	x	Do.

1/ The number of trips was reported all years but was in error from 1936 to 1939, inclusive.

2/ Boston Fish Pier does not include landings at T-wharf.

3/ Hails: Fishing grounds as given by captains at auctions; usually only one ground was given although the vessel might have fished elsewhere.

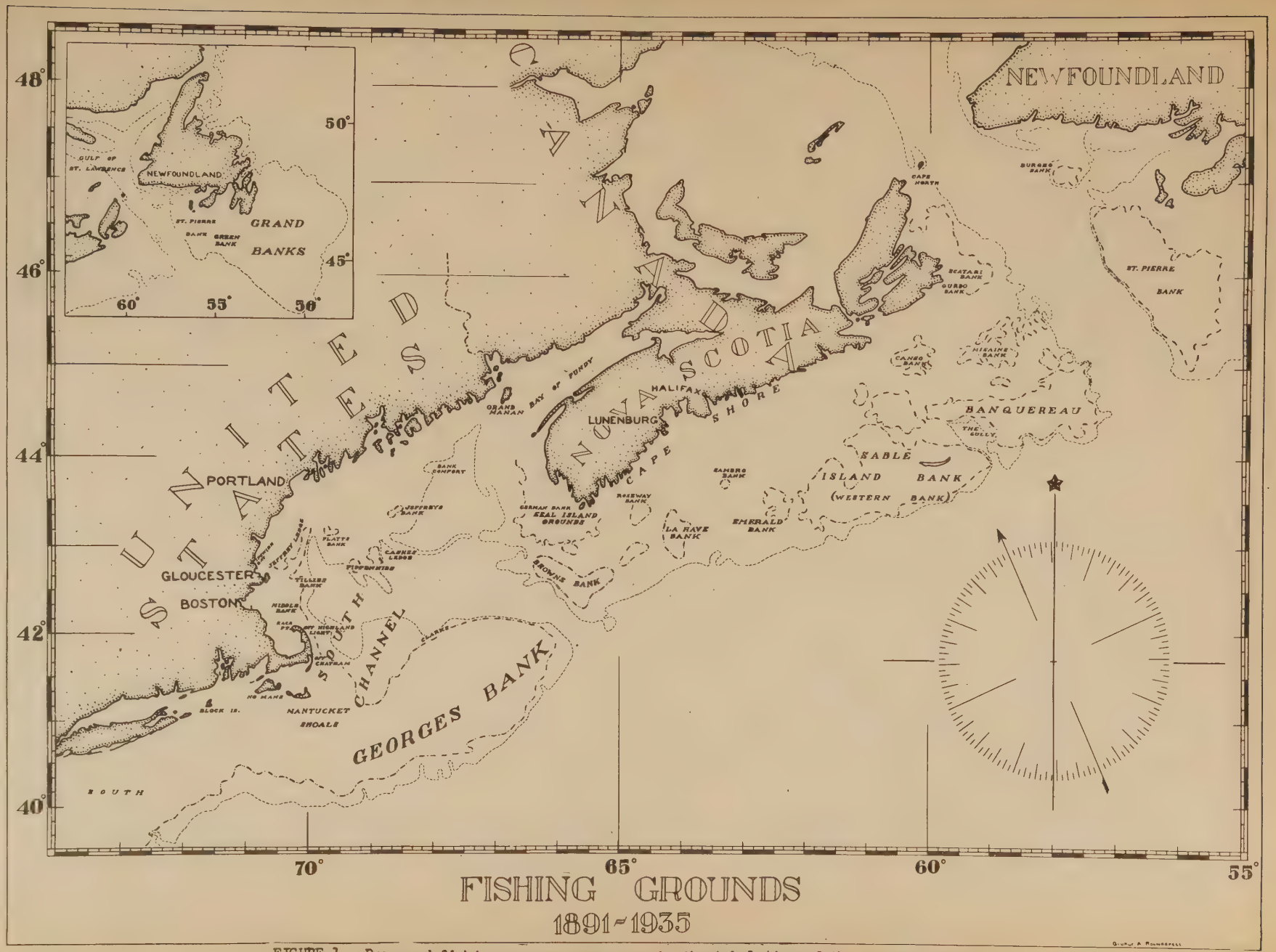

FIGURE 1.—Reported fishing grounds appearing in the tabulation of the catches landed at Boston, Gloucester, and Portland, in the period from 1891 to 1935, inclusive.

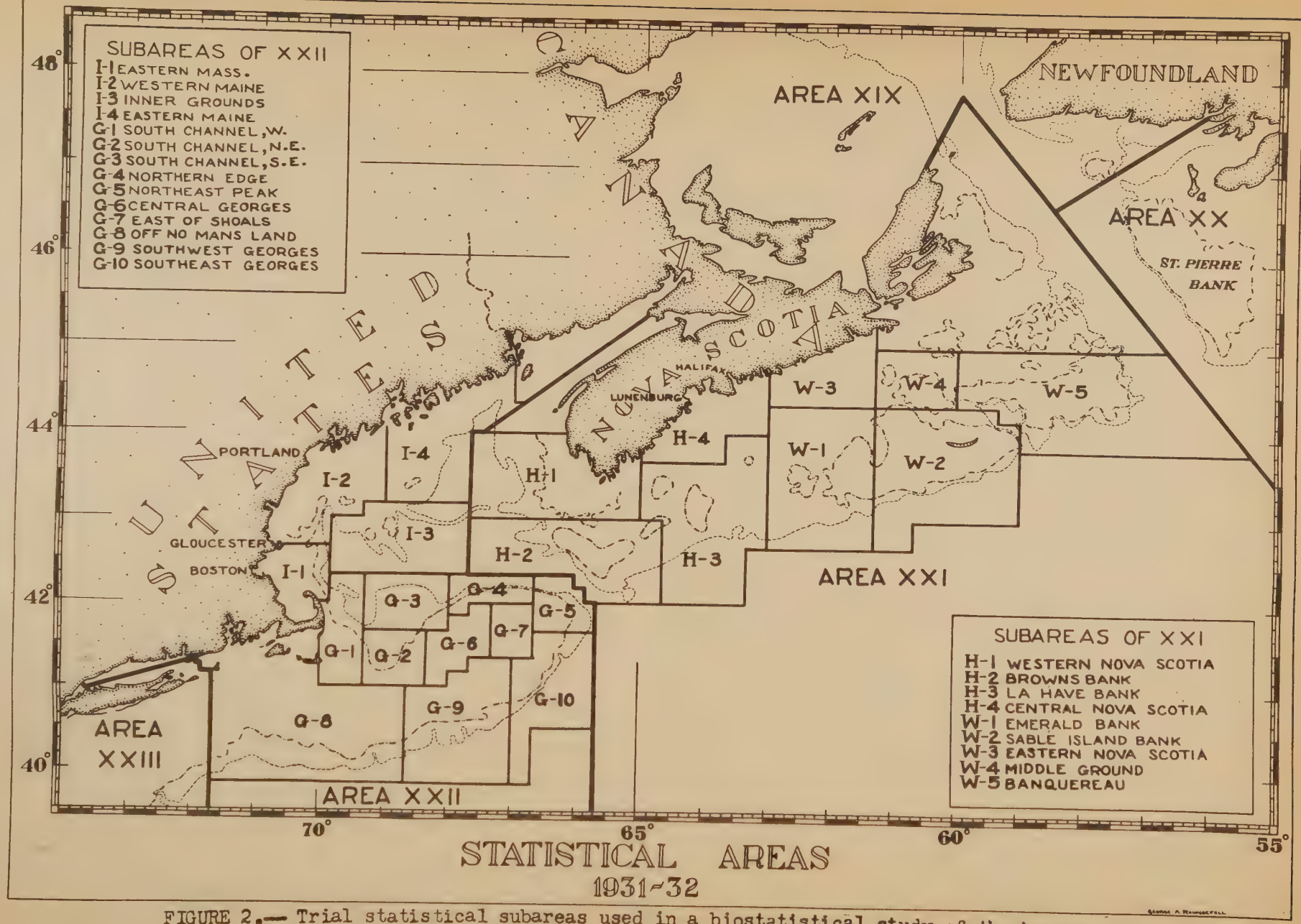

FIGURE 2.— Trial statistical subareas used in a biostatistical study of the haddock fishery, 1931-32. Only the Georges Bank and South Channel areas were divided on the basis of actual data.

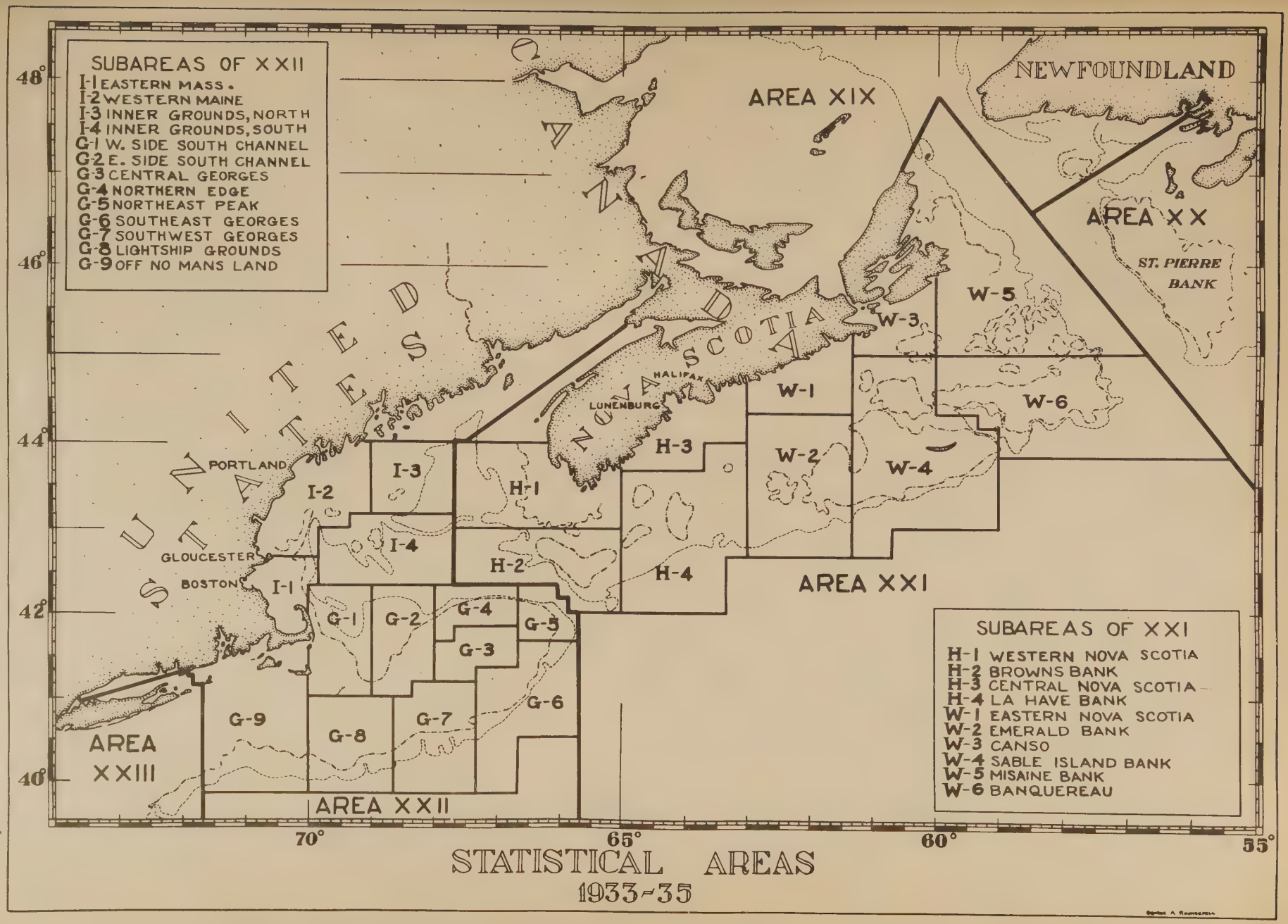

FIGURE 3.—Revised trial statistical subareas used in a biostatistical study of the haddock fishery, 1933-35.

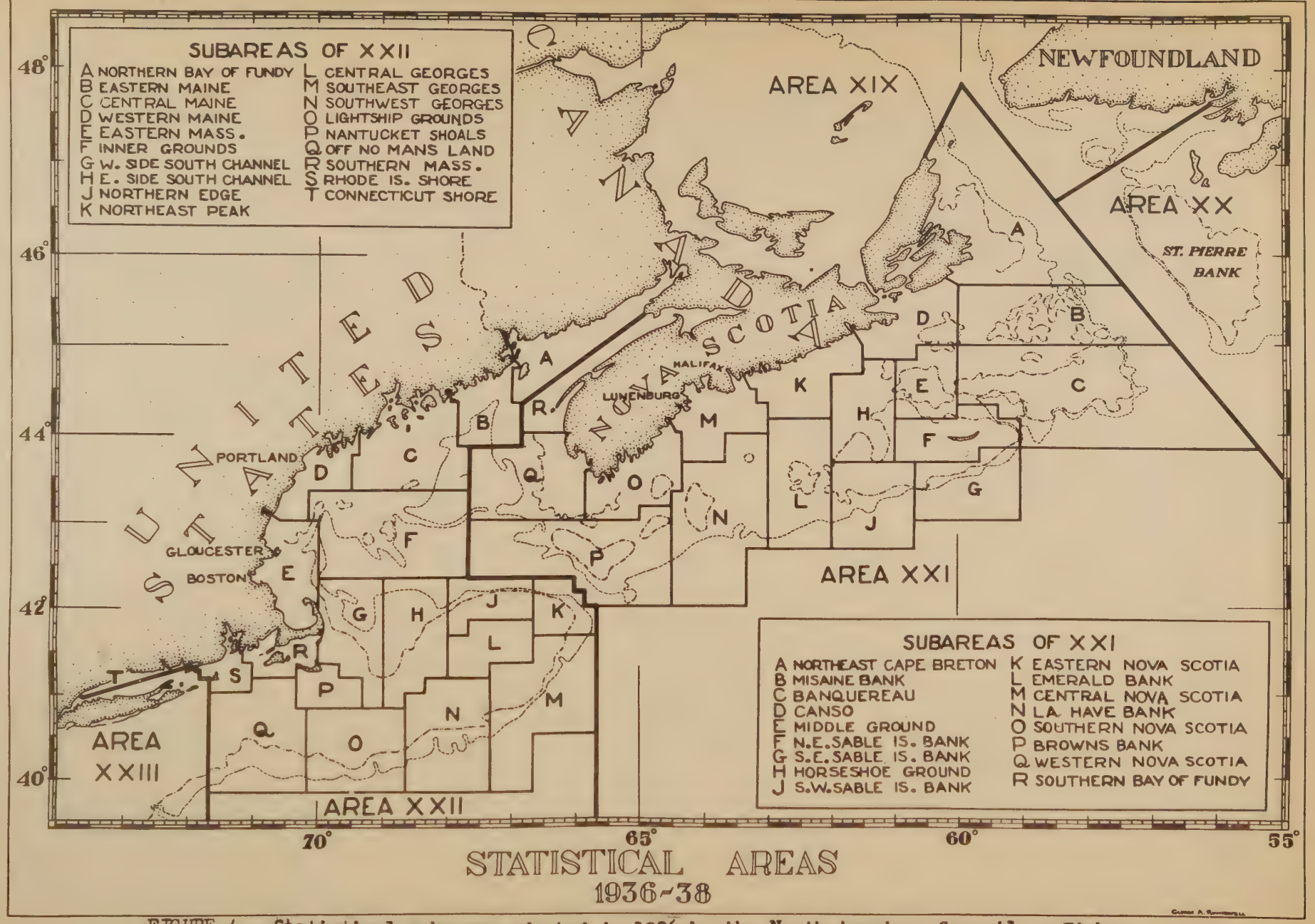

FIGURE 4.—Statistical subareas adopted in 1936 by the North American Council on Fishery Investigations for tabulation of all biostatistical data, including vessel landings at Boston, Gloucester and Portland.

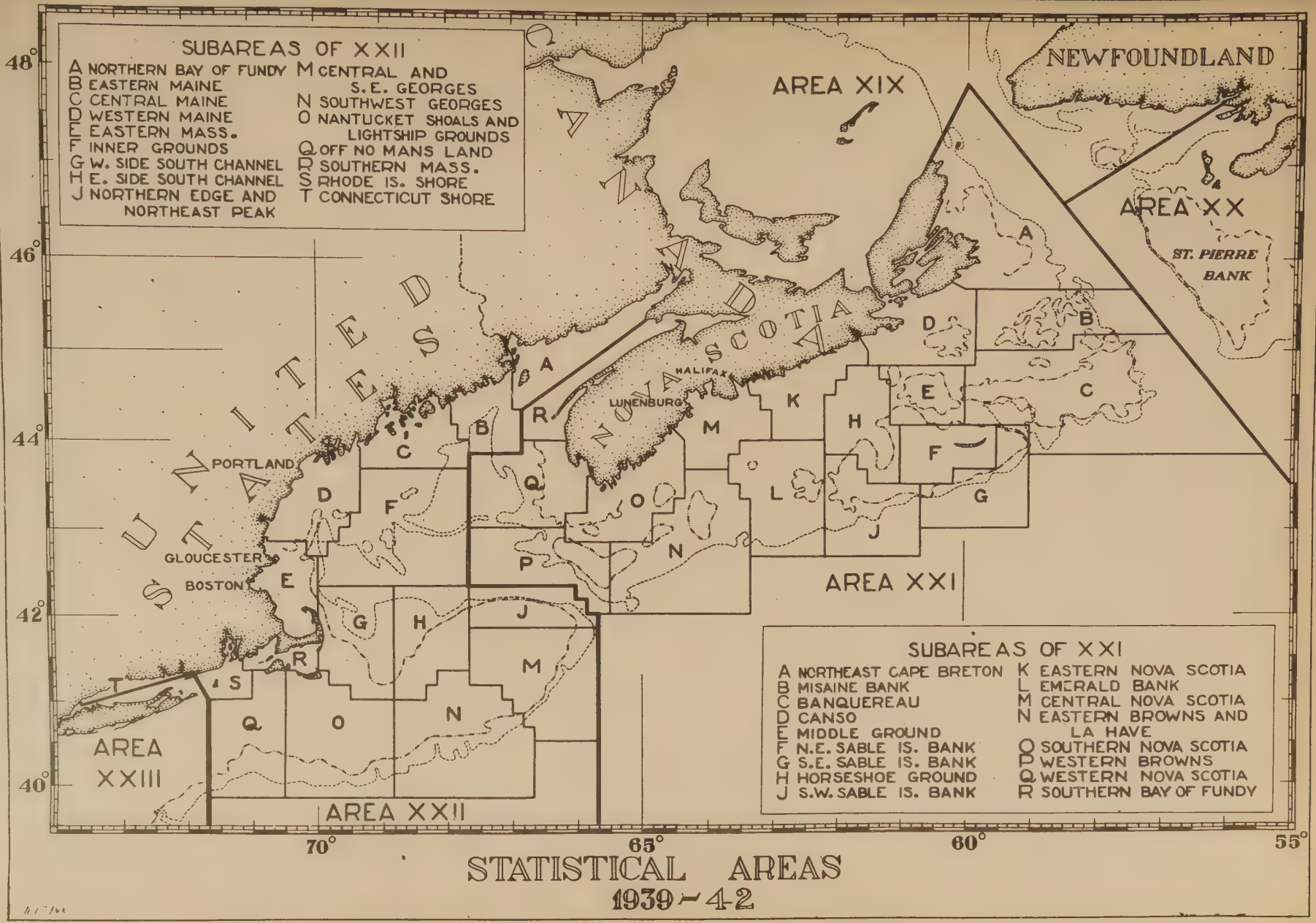

FIGURE 5.—Revised statistical subareas adopted in 1939 by the North American Council on Fishery Investigations for biostatistical data.

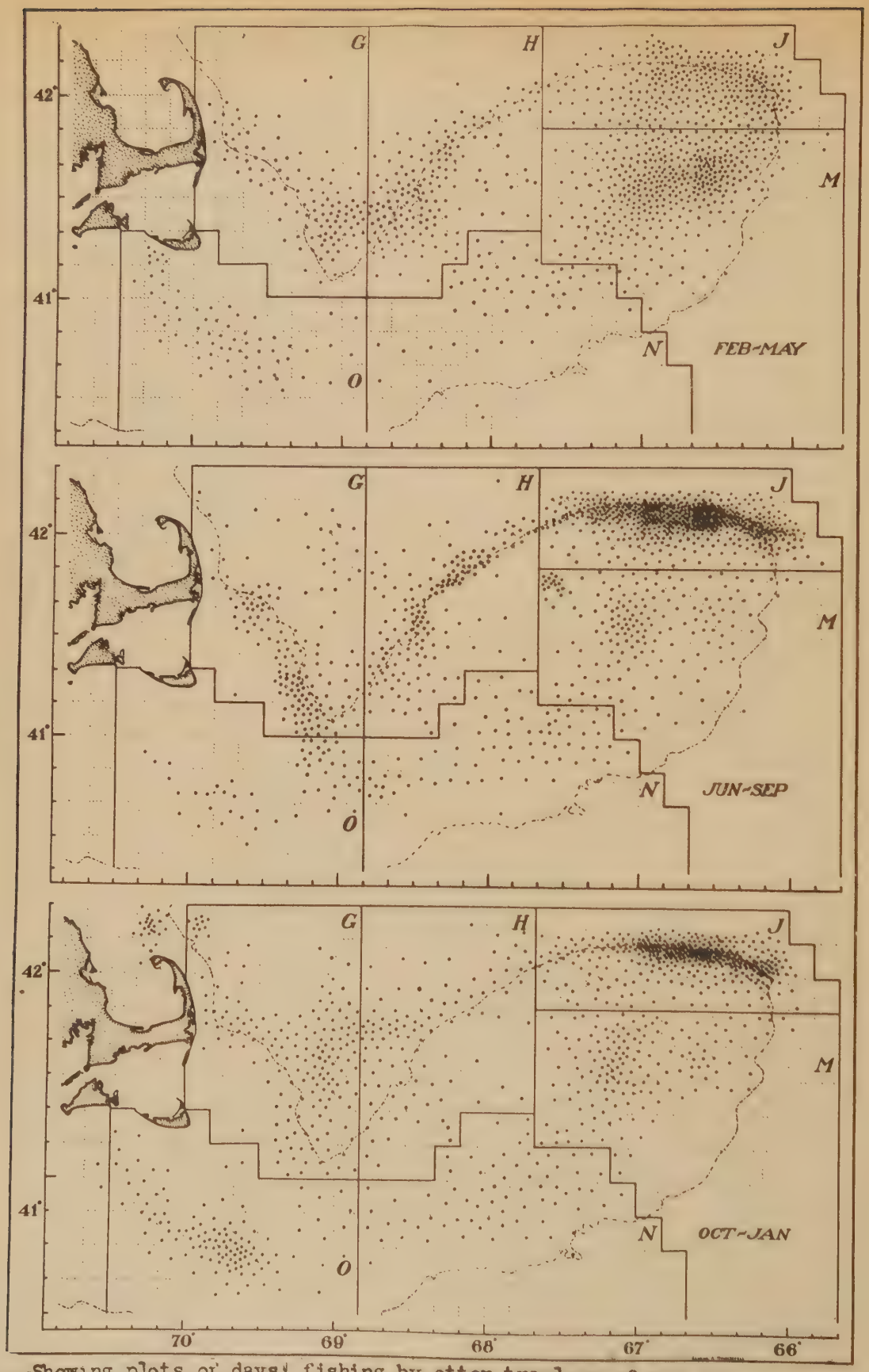

FIGURE 6.—Showing plots of days' fishing by otter trawlers of more than 50 gross tons in Area XXII South (each dot represents 10 days' fishing). This illustrates the manner in which boundaries of the subareas have been drawn so as to separate natural fishing concentrations.

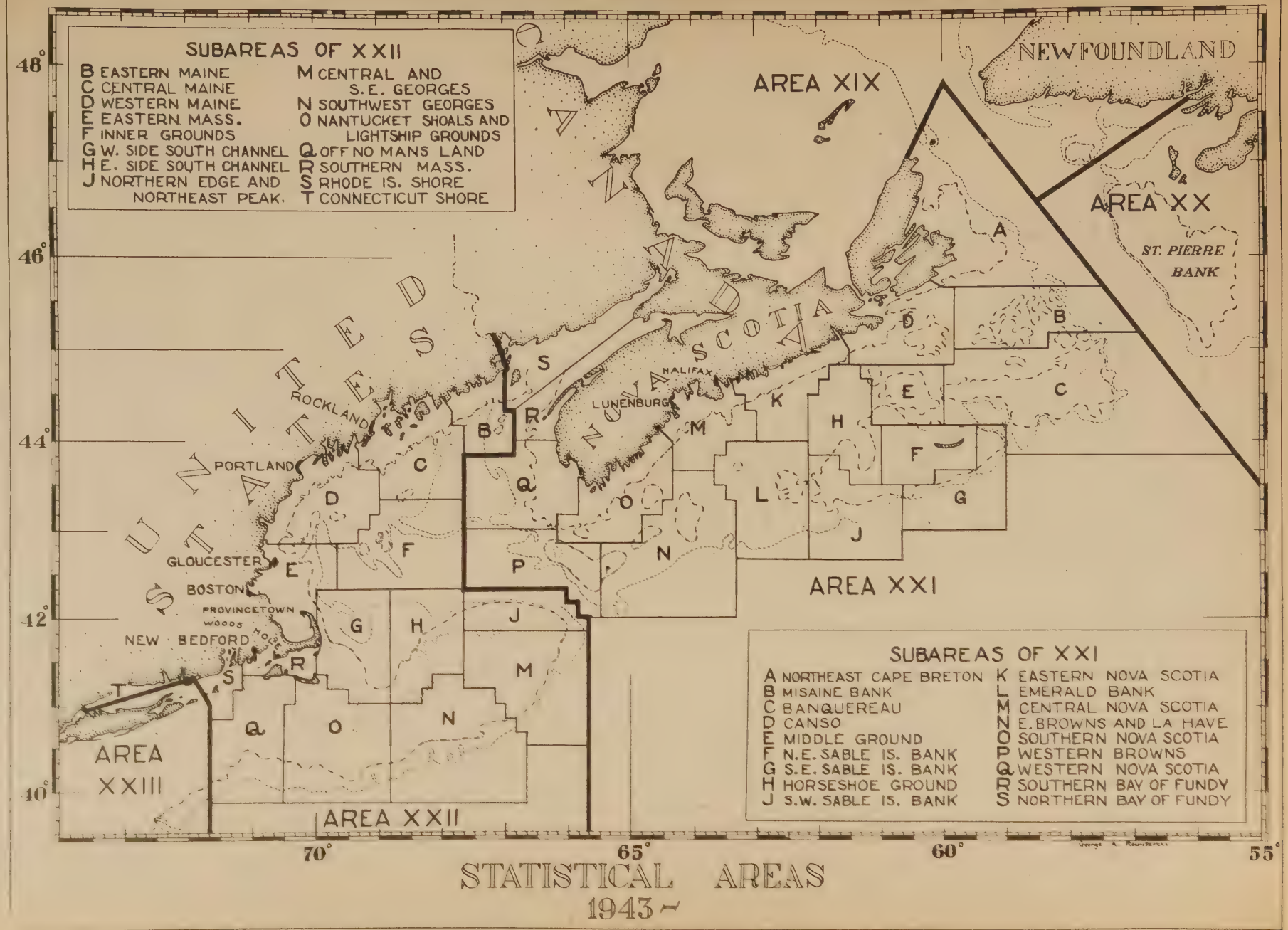

FIGURE 7.—Revised statistical subareas adopted in 1943 for biostatistical data.

FIGURE 8.— Interview chart used by biologist in obtaining information on fishing positions and depths from the vessel captains.

BOAT Ocean Spray DATE 9/12/40

PORT Boston GEAR OTL SER. NO.

SAILED 8/30 / 3p.M LANDED 9/11 5p.M

CAUGHT Horseshoe S. of Island Nor. Edge

FATH.		65-80	28-35	35-47
LOC.		44/61 C_3 D_4	43/60 DEF$_3$	42/66 AB$_6$
POS.			43/59 A_2	42/67 EF$_6$
POS.				
POS.	MACK			
TOT.	LG. MACK	70 M	20 M	40 M
LG. HAD.	TINK MACK	Balance	3 M	10 M
SC. HAD.	BLK. MACK		15 M	5 M
RED	TACK MACK	30 M all		
GRAY S.		25 M	large cod hers	
LEMON S.				all hers
				20 M pollack
EFFORT DAY AND NIGHT		2 days	4 days	30 hrs.
EFFORT DAY				
EFFORT NIGHT				

TIME LOST 18 hrs. jog RUNNING

COLLECTOR B

16—23083

Form 3-1639—DEPARTMENT OF THE INTERIOR—FISH AND WILDLIFE SERVICE

FIGURE 9.—Showing a typical interview of a large otter-trawl vessel, which furnishes data on fishing localities, depths, and fishing effort.